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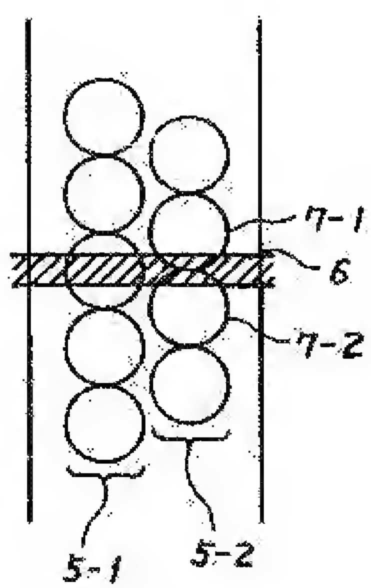
(54) **FOCUSING DETECTOR**



(57)Abstract:

PURPOSE: To maintain high accuracy while maintaining the pitch of photodetectors within the range where the production thereof is easy by providing plural systems of photodetector arrays disposed with a deviation by a prescribed quantity of the element arrays from each other in the array direction of the photodetectors.

CONSTITUTION: If the out-of-focus image 6 of a slit image having a negligible width is projected on photodetector arrays, focusing is judged on the photodetector array 5-1 but the luminous flux is made incident to two photodetectors 7-1, 7-2 on the photodetecor array 5-2 and therefore an out-of-focus is detected. Plural systems of photodetector arrays are used in such a way and the state where all the outputs from the arrays are focused is judged to be a focusing point.

whereby the accuracy in detecting the focusing is improved without increasing the pitch of the photodetector arrays.

SPECIFICATION

1. Title of the Invention

Focus Detecting Device

2. Scope of Claims

1. A focus detecting device in which a light beam from an image forming lens is projected onto a light-receiving device array arranged on a focusing plane of the image forming lens or a plane conjugate with the focusing plane, so as to perform a focus detection of an image from the image forming lens on the basis of a distribution of a light quantity on the light-receiving device array, wherein said light-receiving device array is composed of a plurality of light-receiving device arrays arranged as shifted from each other by a predetermined amount of the device array in the device array direction.

3. Detailed Description of the Invention

The present invention relates to a focus detecting device, and more particularly to a device in which a light beam from an image forming lens is projected to a light-receiving device array arranged on a focusing plane of the image forming lens or on a plane conjugate with the focusing plane, wherein focus detection is performed on the basis of the distribution of light quantity on the light-receiving device array.

One example of the above-described focus detecting device is disclosed in the specification of USP 4,185,191. FIG. 1 is a conceptual view of its optical system. A condenser lens 1 and a small lens array 2 are arranged such that each of

photoelectric conversion devices A1 to An and B1 to Bn arranged at the rear of the small lens array is imaged at the position 3A and position 3B that are a part of an exit pupil of the image forming lens. According to this system, a phase shift e is produced in the distribution pattern of light quantity formed by the photoelectric conversion devices A1 to An and B1 to Bn in an unfocus state as shown in FIG. 2, and when the phase shift becomes zero, a focusing point is detected.

In order to make it possible to detect the defocus for performing the focus detection in the above-described mechanism, it is necessary that a light beam from the same image forming point is incident on at least two or more adjacent light-receiving devices. In view of this, it can be said that the focus detection precision is enhanced as a pitch P upon arranging the light-receiving devices is small. When the spread of the image to which the focus detection is performed is sufficiently smaller than the pitch P, in particular, a precise focus detection is impossible. In order to make the precise focus detection possible for the special image described above, it is necessary that the pitch of the light-receiving devices is preferably several tens to 100 μm in the case of a 35 mm camera, for example. It is difficult to manufacture the light-receiving devices described above. In view of the above-mentioned circumstances, an object of the present invention is to provide a focus detecting device that can maintain high precision while keep the pitch of the light-receiving device within the easy-to-manufacture range.

An embodiment of the present invention will be explained

with reference to drawings.

FIG. 3(a) is a plan view of the light-receiving devices 2 in FIG. 1, and FIG. 3(b) is a similar plan view of light-receiving devices, in place of the light-receiving devices 2 in FIG. 1, according to the present invention. As apparent from the figures, the feature of the light-receiving devices in the present embodiment is that the light-receiving devices, which are conventionally arranged in one row, are arranged in two rows 5-1 and 5-2, wherein the two arrays are arranged proximate to each other as shifted by a half pitch. The use of the light-receiving devices described above can provide a focus detection with precision which is twice as high as that in the conventional case as described below. One example will be described as shown in FIGS. 3(a) and 3(b). When a blurred image 6 that is a slit image whose width is negligible is projected onto the light-receiving device array, a light beam is incident on only one light-receiving device in the conventional light-receiving devices. Therefore, it is determined to be focused, and in the worst case, defocus is not detected until the width d of the blurred image becomes equal to the pitch P of the light-receiving devices. On the other hand, when the light-receiving devices according to the present embodiment are used, defocus is detected on the light-receiving device array 5-2 since a light beam is incident on two light-receiving devices 7-1 and 7-2, although it is determined to be focused on the light-receiving device array 5-1 in FIG. 3(b). Even when the light-receiving devices in two rows are used, the state shown in FIG. 3(c) is determined to be focus. However, the width of the blurred image necessary

for detecting the defocus is at worst a half of the pitch of the light-receiving devices, and this is half that of the conventional case.

The above description is for a one-dimensional blurred image such as a slit. However, if the light-receiving devices in two rows are arranged sufficiently proximate to each other, precision can be enhanced for a two-dimensional image such as a point blurred image.

FIGS. 4(a) and (b) show states in which a blurred point image is projected onto the conventional light-receiving device array and the light-receiving device array according to the present embodiment. Like the previous case, defocus can be detected by the light-receiving devices according to the present embodiment for a blurred image 8 having a size by which the defocus cannot be detected by the conventional light-receiving devices. A state shown in FIG. 4(c) may occur as a special case. In this case, if the diameter of the blurred image 8 is more than 0.73 times the pitch of the light-receiving devices, the defocus can be detected, and hence, it can be said that precision is enhanced compared to the conventional case.

As for a two-dimensional blurred image, a method can be employed in which a low-pass filter is used to blur the image only in the direction perpendicular to the direction of the row of the light-receiving device array, and the image is projected onto the light-receiving device array as a one-dimensional blurred image.

In the embodiment described above, the light-receiving device array is limited to two. However, the light-receiving

device array may be in three rows or more in the present invention. In this case, it is necessary that the shift amount among the arrays is set to 1/(number of arrays).

As explained above, since a plurality of light-receiving arrays are used, and the state in which the output from each array is focused is defined as a focusing point, the precision in the focusing detection can be enhanced, compared to the conventional one, without reducing the pitch of the light-receiving devices, and the light-receiving device is easy to manufacture.

4. Brief Explanation of Drawings

FIG. 1 is a view showing a conventional focus detecting device, FIG. 2 is a view showing an output signal obtained from the device shown in FIG. 1, and FIGS. 3 and 4 are views in which light-receiving devices are viewed in a plane, wherein FIG. 3(a) and FIG. 4(a) show the light-receiving devices in FIG. 1, and FIGS. 3(b), 3(c), 4(b) and 4(c) show light-receiving devices according to the embodiment of the present invention.

In the figures, 5-1 and 5-2 indicate the light-receiving device array, 7-1 and 7-2 indicate the light-receiving device, 6 indicates a blurred image of a slit, and 8 indicates a blurred point image.

FIG. 2

Photoelectric conversion output

Sensor array